# Wetlands Reserve Program (WRP)

## Biological Responses to Wetland Restoration: Implications for Wildlife Habitat Development through the Wetlands Reserve Program

WRP wetland in Iowa (L. Betts)

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### Abstract
*The U.S. Department of Agriculture's Wetlands Reserve Program (WRP) provides incentives for landowners to restore function and value to degraded wetlands in agricultural landscapes. Since authorization of the program in the 1990 Farm Bill, landowner interest in WRP has resulted in enrollment of over 912,000 acres in permanent easements (76%), 30-year easements (18%), or 10-year cost-share agreements (6%). An additional 500,000 acres of unfunded projects have been offered for enrollment into the program. Current WRP enrollments consist of former bottomland hardwood wetlands and riparian floodplain habitats (55%), emergent wetland and open water complexes (15%), and nonwetland buffer areas (30%). In spite of the program's potential benefits for wildlife and popularity with landowners and conservation partners, few studies have been undertaken to evaluate wildlife responses to WRP. Therefore, to make inferences about WRP's effect on wildlife, I reviewed the general literature on wildlife responses to wetland restorations. My review supports the premise that potential benefits of WRP for wetland-associated wildlife are substantial, particularly in regions such as the Lower Mississippi Alluvial Valley and Central Valley of California where significant enrollments have occurred.*

### Introduction
Wetlands provide a variety of ecological, biological, and hydrologic functions that provide economic, aesthetic, recreational, educational, and other values to society (Mitsch and Gosselink 1986, National Research Council 1992, Heimlich et al. 1998). At the time Europeans arrived in North America, there were approximately 224 million acres of wetlands in the conterminous United States (Dahl 1990). By 1992, 45-50% of the original wetland area in this region had been converted to agricultural and other uses, with losses

approaching 90% in some states (Heimlich et al. 1998). The federal government played a significant role in the historic loss of wetlands through public works projects and assorted subsidies and incentives (U.S. Department of Interior 1988). In response to a growing understanding of and appreciation for wetland functions, federal wetlands policy and programs have shifted in recent decades toward providing protection for remaining wetlands and stimulating restoration of previously converted wetlands.

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Since 1992 the USDA Wetlands Reserve Program (WRP) has been a popular program for restoring degraded wetlands in agricultural landscapes. The goal of WRP is to restore function and value to former or degraded wetlands. Conservation practices are undertaken on enrolled lands to restore hydrology, establish hydrophytic vegetation, and maximize wildlife habitat and other wetland functions in a cost-effective manner. Special emphasis is placed on benefits to migratory bird habitat through restoration and enhancement of site hydrology.

In spite of the program's potential benefits for wildlife, few studies have been undertaken to evaluate wildlife responses to WRP. However, wildlife assessments have been conducted on other wetland restoration and creation projects. These results can be used to make inferences about program benefits for wildlife in various regions in the United States. This paper provides a brief description of WRP, characterizes the types of habitats that are being established, summarizes the published literature on the biological responses to wetland restoration activities in general, and makes inferences about WRP benefits for wildlife.

## Program Description

The Wetlands Reserve Program was originally authorized in the 1990 Farm Bill and amended in the 1996 Farm Bill (16 U.S.C. 3837 et seq.). It is a voluntary wetland restoration program, where participating landowners establish conservation easements of either permanent or 30-year duration, or enter into restoration cost-share agreements where no easement is involved. In exchange for establishing permanent easements, landowners receive payments of up to the agricultural value of the land and 100% of the costs involved in restoring the wetlands. The 30-year easement payment is 75% of what would be provided for a permanent easement on the same site and 75% of the restoration cost. Cost-share agreements are for a minimum 10-year duration and provide for 75% of the cost of restoring the wetlands. Wetland protection and restoration are designated the primary land uses for the duration of easements and cost-share agreements. Landowners continue to control access to their land, and compatible uses of easement areas (e.g., timber harvest, grazing, etc.) may be authorized if they are determined by

USDA to be consistent with long-term wetland protection and enhancement goals. The program has a statutory enrollment cap of 975,000 acres.

## Program Delivery/Enrollment

Through June 2000, over 5,230 projects or 912,000 acres had been enrolled in permanent easements (76%), 30-year easements (18%), or 10-year cost-share agreements (6%). Projects range in size from two to 7,000 acres and average 175 acres. An additional 500,000 acres of unfunded projects have been offered for enrollment into the program. Clusters of individual projects are commonplace, especially in marginal flood-prone areas. Although projects are located in 47 states and Puerto Rico, the states with the most activity to date are Louisiana, Mississippi, Arkansas, California, Missouri, Iowa, Florida, Texas, Oklahoma, Illinois, and New York (Fig 1.).

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A wide variety of freshwater wetlands in various geomorphological settings have been restored through the program. Once enrolled, wetlands are restored by physically manipulating the site to the extent necessary to restore hydrology, hydrophytic vegetation, and topographic surface features characteristic of natural wetlands. In large river floodplains that have been modified by construction of flood control levies, channelization, other large-scale drainage activities, and land leveling, this may involve constructing low-level levies to hold water on the restoration sites and excavation of shallow swales to mimic natural hydrologic conditions and surface features. Frequently, heavy-seeded tree species are planted to begin the process of restoring bottomland hardwood vegetation on these sites. In drained prairie potholes and other depressional wetlands, restoration of hydrology involves construction of earthen plugs on drainage ditches or breaking drainage tiles. A variety of water control structures are employed to provide management capabilities to many sites, enhancing their potential for management to maximize wildlife habitat functions.

The program has been embraced by wildlife managers as a critical tool for meeting wetland habitat goals on private lands. For example, in the Lower Mississippi Alluvial Valley, WRP is seen as the major avenue to accomplishing the 521,000-acre bottomland hardwood wetland habitat restoration objective set by the North American Waterfowl Management Plan's Lower Mississippi Valley Joint Venture (Baxter et al. 1996). WRP also is being employed to meet wildlife habitat objectives in the Central Valley of California, Prairie Pothole Region, and other parts of the country that have experienced substantial wetland habitat losses. Due to the program's potential to provide significant habitat accomplishments, diverse partnerships have formed to assist in program delivery. The U.S. Fish and Wildlife Service, U.S. Forest Service, Ducks Unlimited, state fish and wildlife agencies, waterfowl associations, and a variety of other entities are heavily engaged in various aspects of WRP implementation in the field.

Due to the short time the program has been operational, most wetlands enrolled have been restored only within the past few years and are in the early stage of vegetation development. Habitat types being targeted by WRP are bottomland hardwood forest, emergent marsh/open water wetlands, western riparian wetlands, and nonwetland buffer areas.

### Bottomland Hardwood Forest

***Approximately 50% of all lands currently enrolled in WRP consist of former bottomland hardwood forests . . .***

Approximately 50% of all lands currently enrolled in WRP consist of former bottomland hardwood forests that have been used for agriculture. These occur primarily in large river floodplain bottomlands of the lower Mississippi River and its tributaries and other river systems of the south and east. Restoration activities typically involve restoring hydrology and planting three to seven species of bottomland hardwood trees. Table 1 provides an example of one state's list of tree species planted on bottomland hardwood restoration sites. Tree species planted are intended to eventually become dominant in the bottomland hardwood forest overstory. While many WRP bottomland hardwood restoration sites have developed emergent vegetation, over time it is projected that diverse forested wetland communities will develop.

In many instances, existing drainage and levy systems prevent fully restoring floodplain hydrology to WRP sites (King and Keeland 1999). Therefore, smaller levies, ditch plugs, and water control structures are constructed onsite to mimic surrounding natural hydrologic conditions to the extent feasible. In addition, since many WRP restoration sites have been conditioned through precision land leveling and farming activities, swales, small pits, and other surface features may be excavated to recontour the surface, providing a range of soil moisture conditions and local habitat features.

### Emergent Marsh and Open Water

Approximately 15% of the area enrolled in WRP consists of emergent wetland and open water complexes. Some of these areas occur on small portions of bottomland hardwood contracts that are expected to remain in open water or herbaceous vegetation, but most occur in prairie grassland settings, marshlands of California's Central Valley, and other nonforested landscapes. Restoration is generally accomplished by breaking drainage tiles, installing ditch plugs, and constructing low-level earthen berms to restore wetland hydrology. In areas that have been land-leveled to facilitate production of rice and other crops, shallow swales may be excavated to reestablish more natural surface topography and provide areas with more permanent hydroperiod. Herbaceous wetland vegetation is established primarily through natural colonization and germination of wetland plant seeds stored in the soil seedbank.

### Riparian Wetlands
Riparian wetland restoration comprises approximately 5% of the acres enrolled in WRP. These areas are primarily associated with river systems in the western United States. Riparian vegetation is reestablished on these sites primarily through natural regeneration and control of salt cedar and other exotic species.

### Nonwetland Buffer
Approximately 30% of acres enrolled consist of nonwetland buffer areas. The amount of upland buffer included in WRP contracts varies widely among regions and individual enrollments. For example, an enrollment containing a complex of prairie pothole wetlands may include a significant amount of upland grassland useful as dense nesting cover for waterfowl and other wildlife. However, an enrollment on a large river floodplain may consist entirely of wetland to be restored. Program policy dictates that no more than 50% of an individual enrollment consist of nonwetland area. However, this requirement may be waived in cases where important wetland complexes are enrolled.

## Biological Responses to Restored Wetland Habitats
Below is a summary of published information on biological responses to wetland restoration and creation efforts by wetland type.

### Bottomland Hardwood Forest and Riparian Wetlands
Much attention has been given in recent years to the effectiveness of restoring bottomland hardwood wetland systems in the Southeast (Newling 1990). Much of the work done has focused on the challenge of establishing wetland hydrology in light of large-scale hydrologic alterations and social conditions, and establishing diverse stands of bottomland hardwood tree species. Reforestation efforts are based on silvicultural principles (see Fowells 1965), planting bottomland hardwood forest overstory trees and natural regeneration of vegetation on the site. Local problems, such as drought, herbivory, and flooding, can limit success (King and Keeland 1999).

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The majority of bottomland hardwood wetlands restored through WRP are former agricultural fields. For all practical purposes, it will be some time before these areas begin to resemble the forested wetland communities that formerly characterized the region. In the meantime, these areas provide wetland functions and habitats similar to those provided by emergent wetlands. For purposes of this assessment, documented biological response to emergent wetland restoration and establishment actions will be assumed to also apply to these early developmental stages of bottomland hardwood restoration projects. In addition, the following observations can be made that apply to recently restored bottomland hardwood wetlands.

*Vegetation*

Tree seedling survival is an important aspect of determining success of bottomland hardwood restoration (Allen and Kennedy 1989). Seedling growth and survival varies by species and site condition (Teskey and Hinckley 1977). Wallace et al. (1996) found that planted red maple, pop ash, pond pine, pond cypress, and bald cypress seedlings can reasonably be expected to survive at least one year under a broad range of hydrological and soil conditions. Competition with herbaceous vegetation is an important factor, but tree seedling planting site elevation and associated soil moisture and flooding has been shown to be more important for seedling growth and survival than control of herbaceous vegetation competition (McLeod et al. 2000). Thus, establishment of appropriate hydroperiods and site topography provides a variety of planting elevations and helps ensure greater probability of planted tree seedling growth and survival (Barry et al. 1996, Deitz et al. 1996, King and Keeland 1999).

*Birds*

***Bird communities in restored bottomland hardwood forests change over time in response to development of vegetative structure . . .***

Bird communities in restored bottomland hardwood forests change over time in response to development of vegetative structure (Nuttle and Burger 1996, Twedt and Portwood 1997). While total bird abundance may remain relatively constant through time, species richness has been shown to increase with stand age (Nuttle and Burger 1996). As the forested community matures, the bird community shifts from grassland species to forest dwelling species (Wilson and Twedt, in press). Management prescriptions that mimic natural succession such as mixed plantings or thinning are believed to promote early colonization by birds associated with mature forests (Nuttle and Burger 1996).

Twedt and Uihlein (in press) developed a method for geographically prioritizing reforestation efforts in the Lower Mississippi Alluvial Valley based on habitat needs of forest breeding landbirds. They found that Bird Conservation Regions identified in Partners in Flight's Bird Conservation Plan for the Lower Mississippi Alluvial Valley encompassed approximately 70% of the area identified by the method as high priority for reforestation. They also found that lands enrolled in WRP in the region contain a high proportion of lands with high reforestation priority, indicating the potential for WRP reforestation sites to benefit forest breeding land birds. However, Wilson and Twedt (in press) found that forest landbirds did not colonize bottomland hardwood forest plantings until 15 years after planting. They recommend planting some fast-growing tree species to provide vertical structure more quickly to benefit forest birds earlier. However, other wildlife species benefit from the emergent wetlands associated with early successional stages of forested wetland restoration efforts. Bird communities of these recently restored sites are frequently similar to that of comparable natural herbaceous wetlands (Brown and Smith 1998).

Horizontal and vertical foliage diversity in riparian floodplain areas are positively correlated with the number of bird species using an area (Anderson et al. 1979). In riparian areas along the lower Colorado River, Anderson and Ohmart (1984) found that vegetation growth and avian colonization occurred rapidly after restoration. Cottonwood, willow, and quail bush were associated with increased avian use. Elimination of exotic salt cedar and leaving native vegetation also enhanced avian use of riparian areas.

In some situations, forested wetlands have been impacted by drainage but not cleared. Although the forest vegetation remains, wetland functions are reduced or eliminated due to lack of wetland hydrology and changes in vegetation species composition in response to altered water regimes. Wetland functions may be recovered in these areas by returning the wetland hydrology and other management actions. Weller (1995) found that wetland habitat functions returned to a drained south Florida wetland within three years of reestablishing wetland hydrology and removal of exotic Brazilian pepper (*Schinus terebinthifolius*) vegetation. The restoration action resulted in the return of 16 wetland bird species, eight fish species, six species of turtles, six species of snails, two frog species, and the American alligator (*Alligator mississipiensis*).

Aquatic plants return one year after restoration. (C. Rewa)

### Freshwater Emergent Wetlands

*Vegetation*

In most situations, wetland vegetation quickly colonizes restored wetlands on abandoned agricultural fields following the return of wetland hydrology (LaGrange and Dinsmore 1989, Anderson 1991, Sewell and Higgins 1991, Galatowitsch and van der Valk 1996*a*, Brown 1999). Reaves and Croteau-Hartman's (1994) review of the published literature indicated that native aquatic plants generally return to restored wetlands within one year following restoration of wetland hydrology. LaGrange and Dinsmore (1989) found a total of 45 plant species in four formerly restored wetlands several years after they were reflooded.

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Size of restored basins influences rate of revegetation. Guggisberg (1996) found that cattails quickly colonized smaller restored herbaceous wetlands in Wisconsin, while larger basins developed greater vegetation diversity. Brown (1999) found that plant communities at restored wetland sites in New York became increasingly similar to those of natural wetlands over time.

Rapid colonization of wetland vegetation primarily is due to germination of seeds persisting in drained wetland soils after wetland hydrology has been restored (Weinhold and van der Valk 1989) or dispersal from other areas. Though natural wetland plant colonization typically is rapid, introduction of wetland soils from other sites may augment natural regeneration of wetland plants (Brown et al. 1997). Trees and shrubs from adjacent sites also have been successfully transplanted to restored wetlands using construction equipment while restoration work is being conducted (Lehman et al. 1999).

Basin morphology also plays a role in wetland vegetation response (Rossiter and Crawford 1986). Galatowitsch and van der Valk (1996*a*) studied basin characteristics of 62 recently restored prairie wetlands in Iowa, Minnesota, and South Dakota. Most restored wetlands had basin morphologies comparable to natural wetlands, met or exceeded predicted hydrology, and had developed emergent and submersed aquatic vegetation zones. However, only a few basins developed wet prairie and sedge meadow zones.

The method of drainage also affects how quickly wetland vegetation returns and initial species composition. Galatowitsch and van der Valk (1993) found that tile-drained wetlands had fewer wetland plants than ditch-drained wetlands due to thoroughness of drainage and lack of refugia for wetland plants. Regardless of drainage history, they found that recently restored prairie wetlands lacked the perimeter zones of wet prairie and sedge meadow vegetation. Whereas many submersed aquatic plants are able to colonize restored basins rapidly, some emergent and wet meadow species may take longer to become established. Galatowitsch and van der Valk (1996*b*) found that three-year-old restored prairie wetlands in Iowa had more species of submerged aquatic plants after reflooding than did natural wetlands.

*Invertebrates*

Restored wetlands may be quickly colonized by a variety of aquatic invertebrates and other animals (Reaves and Croteau-Hartman 1994). Brown et al. (1997) found similar invertebrate taxa between natural wetlands and restored wetlands in New York. Insects with aerial dispersal colonized restored wetlands more rapidly than less mobile invertebrates. Surface mine sediment ponds were colonized by 66 invertebrate taxa in the first year and 44 invertebrate taxa second year after construction (Fowler et al. 1985).

***The invertebrate fauna of restored wetlands resembles that of natural wetlands with similar vegetation structure . . .***

The invertebrate fauna of restored wetlands resembles that of natural wetlands with similar vegetation structure (Brown et al. 1997). Mayer and Galatowitsch (1999) found diatom species richness and composition in restored prairie wetlands in North Dakota to be similar to that of natural wetlands. LaGrange and Dinsmore (1989) found a total of 18 wetland invertebrate species in four restored prairie wetlands several years after they were reflooded. In a survey of 156 restored seasonal and semipermanent wetlands in Minnesota and South Dakota, Sewell and Higgins (1991) found 31 taxa of aquatic macroinvertebrates in restored wetlands, 12 of which occurred in the first year following restoration.

Benthic invertebrate communities are strongly associated with wetland vegetation (Streever et al. 1995). In a created freshwater wetland in central Florida, Streever et al. (1995) found three of five common chironomid genera were more abundant in areas with greater than 50% herbaceous cover than more open areas; abundance of five common genera was greatest in areas with > 80% vegetative cover. Transplantation of remnant wetland soil that increases the rate of wetland plant establishment also can increase overall invertebrate abundance in restored wetlands (Brown et al. 1997).

Invertebrate taxa used to assess biotic response to restored wetlands vary temporally and spatially (Brown et al. 1997). Ettema et al. (1998) found spatial distribution within a restored wetland in Georgia varied substantially among nematode taxa, with substantial temporal variation within taxa. Distribution of nematode taxa did not correlate well with soil resource patterns. In a rehabilitated wetland in northern Spain, Valladares Diez et al. (1994) found that a diverse community of Coleoptera had developed, but most species found belong to early successional groups or are ubiquitists. In the same restored wetland, Gonzales Martinez and Valladares Diez (1996) found aquatic Heteroptera and Odonata communities to be similar to natural immature wetlands (ubiquitists and pioneers). In general, the communities of beetles, dragonflies, and aquatic heteraopterans are representative of recent wetlands, with evidence of changes toward a more stable and mature environment.

*Reptiles and Amphibians*

Several studies illustrate rapid amphibian colonization of constructed and restored wetlands. Fowler et al. (1985) documented 12 species of breeding amphibians in surface mine sediment ponds constructed in western Tennessee; all ponds surveyed contained at least one breeding amphibian species. Anderson (1991) found American toads (*Bufo americanus*), green frogs (*Rana clamitans*), and leopard frogs (*Rana pipiens*) using recently restored wetlands in Wisconsin. Lacki et al. (1992) found that a wetland constructed for treatment of mine water drainage in east central Ohio supported greater abundance and species richness of herpetofauna than surrounding natural wetlands. This was primarily due to the large number of green frogs and pickerel frogs and numerous species of snakes found using this site.

Landscape condition and surrounding land use are critical components that influence amphibian use of restored wetlands. In glacial marshes in Minnesota, Lehtinen et al. (1999) found amphibian species richness was lower with greater wetland isolation and road density at all spatial scales in both tallgrass prairie and northern hardwood forest ecoregions. Likewise, elimination of small wetlands that are relied upon by reptiles and amphibians can have a devastating effect on habitat availability and populations of these animals (Gibbs 1993).

***Landscape condition and surrounding land use are critical components that influence amphibian use of restored wetlands.***

*Birds*

Numerous studies have documented extensive bird use of restored freshwater wetlands. LaGrange and Dinsmore (1989) found a total of 11 bird species in four formerly drained prairie wetland basins several years after the basins were reflooded. Anderson (1991) monitored wildlife use of small restored wetlands in Wisconsin and documented use by nesting ducks, marsh wrens, sandpipers, and woodcock. Although no quantitative data were collected, Oertel (1997) noted substantial increases in wetland-associated wildlife use following restoration of a 55-acre wetland in northern New York. Dick (1993) observed wetland-dependent birds using an 80-acre restored wetland site in south central Pennsylvania during the first year after restoration. Bird groups observed included winter raptors, wintering and migrating ducks, geese and tundra swans, foraging wading birds, waterfowl and shorebirds, and other birds. Breeding mallards, wood ducks, sora rails, sedge wrens, common snipes, spotted sandpipers and pied-billed grebes were documented. Restoration of the wetland increased bird diversity by 60% during the first year.

In most situations, birds rapidly colonized restored wetlands, usually in the first year after restoration. Delehanty and Svedarsky (1993) found breeding black terns using a restored prairie wetland during the second and third breeding seasons after restoration. As many as 40 adults were present in the marsh during the third breeding season, and a minimum of seven young were fledged. Sewell and Higgins (1991) found 12 species of waterfowl using restored wetlands of varying ages in Minnesota and South Dakota. During the first five years after restoration, White and Bayley (1999) documented 50 shorebird species, 44 waterfowl species, 15 raptor species, and 28 other new bird species using a 1,246-ha northern prairie wetland that was restored and flooded with municipal wastewater. These studies clearly show how quickly wetland-associated birds respond to restored wetland habitats.

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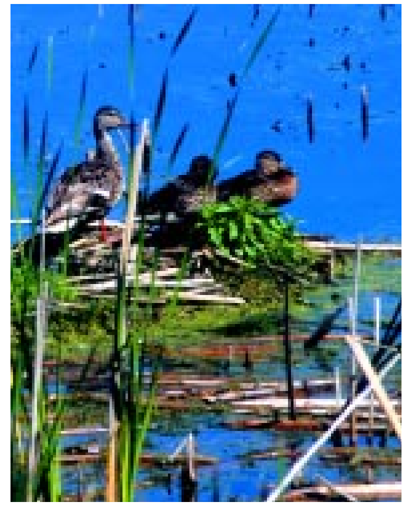
Bird use generally increases with the size of restored wetlands. Brown and Dinsmore (1986) found more diverse bird communities in larger prairie marshes. Among restored emergent wetlands in Wisconsin, Guggisberg (1996) found that large restored wetlands had greater nongame bird species richness than did small wetlands. In restored herbaceous wetlands in northern Iowa, Hemesath and Dinsmore (1993) found that breeding bird species richness increased with wetland size, regardless of the age of the wetlands or duration of drainage. However, plant succession influences bird use of restored basins (Wilson and Twedt, in press). Vanrees-Siewert and Dinsmore (1996) found that total bird species richness increased with age of restored prairie wetlands in Iowa, while waterfowl use (breeding and total) was influenced by restored wetland size, regardless of age.

Habitat structure in restored wetlands appears to be the primary element that determines bird use. Density of waterfowl breeding pairs was lower in borrow ponds constructed along a highway in North Dakota than in natural basins of similar size (Rossiter and Crawford 1981, 1986). This was attributed to lack of shallow water area and emergent wetland vegetation in borrow area wetlands. During drought conditions, Ruwaldt et al. (1979) found spring waterfowl pair use in South Dakota was greater in semipermanent natural wetlands and artificial stock ponds than in other wetland types, indicating the importance of surface water availability to breeding waterfowl.


Mallard hen and brood (C. Schwartz)

Bird use of restored wetland systems has been shown to be similar to that of natural wetlands with similar habitat structure (Brown and Smith 1998). Brown and Smith (1998) found that the number of bird species and bird abundance did not differ between restored and natural wetlands in New York for the three bird groups studied (wetland-dependent, wetland-associated, and nonwetland birds). They found bird communities were more similar among restored sites than between restored and natural wetland sites. Delphey and Dinsmore (1993) found species richness of breeding birds was higher at natural wetlands than restored prairie wetlands. However, duck species richness and pair counts did not differ between natural and restored wetlands. Drought during the study may have influenced results.

Brown (1999) found more wildlife plant foods and greater coverage of these plant species in restored wetlands than in natural wetlands in New York. Differences in bird similarity between natural and restored wetlands may disappear as restored wetlands develop over time (Brown and Smith 1998).

***Bird use . . . is influenced by characteristics of wetland complexes and adjacent land uses . . .***

Bird use also is influenced by characteristics of wetland complexes and adjacent land uses (e.g., Reaves and Croteau-Hartman 1994). Whereas local wetland features dictate suitability for less mobile wetland bird species, wide-ranging species are greatly affected by the characteristics of the surrounding landscape. For example, Naugle et al. (1999) found that while pied-billed grebes and yellow-headed blackbirds used wetlands in South Dakota based on site conditions, use of wetlands by black terns, a wide-ranging species, was dictated more by surrounding land uses. Fairbairn (1999) found bird diversity within wetland complexes to be positively associated with the percentage of wetland area with emergent vegetation, total wetland area within 3 km, and total area of semipermanent wetlands. Naugle et al. (2000) found black tern use of prairie wetlands was correlated with wetland area, amount of semipermanent wetland area within the wetland, and grassland area in the surrounding landscape. Black tern use was associated with large wetland basins located in high-density wetland complexes, illustrating the importance of considering entire landscapes in habitat assessments and conservation efforts.

## Landscape Effects

As previously indicated, surrounding land use can affect wildlife use of restored wetlands (Wilson and Mitsch 1996, Naugle et al. 1999). Lehtinen et al. (1999) suggest that regional wetland conservation strategies should include reversing trends in habitat fragmentation. Effective regional strategies must include restoration of a diversity of wetland types, including small and rarer wetland types as well as historically more extensive wetland systems (Gibbs 1993, Detenbeck et al. 1999), and providing adequate upland buffers around wetlands and within wetland complexes.

Provision of wetland complexes, vegetative diversity, interspersion of water and vegetation, and wetland configuration and edge were identified as important factors influencing waterfowl habitat potential (Weller 1990). In studying characteristics of restored prairie wetlands, Galatowitsch and van der Valk (1996*a*) argued that success of restoration efforts was limited by the number of wetland basins affected (i.e., scale). They recommended that emphasis should be placed on restoring complexes of wetlands representing a variety of wetland classes and sizes. To address this issue, Galatowitsch et al. (1998) suggested using a planning framework for restoration of prairie wetlands that focuses on restoring wetland complexes rather than on isolated wetland basins, and that restoration expectations based on this concept should be used in evaluating success of prairie wetland restoration efforts. Similarly, Bedford (1999) suggested that, to increase the chances of providing wetland functions on the landscape, an analysis of cumulative wetland impacts in regional wetland restoration planning should be undertaken.

Although careful planning is important, it is difficult to precisely predict vegetation and wildlife response to created or restored wetlands (Malakoff 1998). Additional time and allowance for natural processes to shape the wetland should be considered in implementing wetland establishment projects. Specifically, adaptive management and corrective measures should guide the restoration process through time (Weinstein et al. 1997). Complete restoration of wetland functions may require 15 to 20 years (Mitsch and Wilson 1996).

***Monitoring progress of restored wetland systems is important . . .***

Monitoring progress of restored wetland systems is important (Metzker and Mitsch 1997). Until recently, very little effort has been placed on short-term or long-term monitoring of restored wetlands (Lewis et al. 1994). Monitoring to compare restored wetlands to natural wetlands over time regarding rates of revegetation, use by animal species, development of soil profiles and patterns of vegetation change is needed (Lewis et al. 1994).

When planting vegetation is necessary, native plant materials from local genetic stocks should be used to maximize success and avoid impacts to native flora and fauna in the area (Padgett and Crow 1994). Monitoring development of restored wetlands allows wetland managers to identify and possibly prevent problems associated with invasive species and other management challenges.

Wetland restoration and creation is an evolving discipline (Zedler 1987). Young (1996) pointed out the complexity of creating wetland systems and the importance of establishing wetland hydrology in wetland construction work. While the focus of wetland restoration work is largely on restoring wetland hydrology and vegetation, restoration work should be multidisciplinary, integrating water quality, wildlife habitat, flood abatement, and other benefits (Almendinger 1998, Montgomery 2000).

Waterfowl in WRP wetland (C. Schwartz)

## Wildlife Benefits of WRP

Over 915,000 acres are currently enrolled in WRP, mostly in permanent easements. While actual wildlife use of these lands has not been determined, the literature on wildlife use of other restored wetlands suggests that many species likely are benefiting from the habitats being created through this program. The lack of information prevents us from making definitive statements about wildlife benefits of the program. Nonetheless, the extent and variety of wetland habitats being created, and similarity of WRP areas to other wetland restorations, supports the premise that potential benefits of WRP for wetland-associated wildlife are substantial.

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For example, in the Southeast, bottomland hardwood forests restored under WRP are contributing significantly to reaching regional habitat goals of the North American Waterfowl Management Plan (Baxter et al. 1996). Although many of these wetlands presently are vegetated with early successional plants, they eventually will develop into bottomland hardwood forests. Additionally, since many WRP sites in the Lower Mississippi Alluvial Valley occur in high priority bird conservation areas (Twedt and Uihlein, in press), it is probable that they will play an increasingly important role in the conservation of migratory landbirds, as well as waterfowl.

Similarly, the literature suggests that most restored emergent wetlands are quickly vegetated and colonized by a variety of wetland wildlife species (Anderson and Ohmart 1984, Anderson 1991, Sewell and Higgins 1991, Dick 1993, Brown and Smith 1998). In the Prairie Pothole Region of the Dakotas, Minnesota, and Iowa, where creation of wetland complexes is of particular importance for breeding waterfowl and other wildlife, WRP and other wetland restoration efforts will play a critical role in achieving bird conservation objectives (Delehanty and Svedarsky 1993, Delphey and Dinsmore 1993, Galatowitsch et al. 1998, Fairbairn 1999). The upland areas established within WRP land enrollments provide upland nesting cover for waterfowl and other wildlife, and also serve to protect restored wetlands from siltation and other impacts associated with adjacent land use (see Naugle et al. 2000).

***Additional monitoring is needed to gain a better understanding of wildlife responses to management and program benefits for wildlife.***

It is difficult to quantify the contributions that WRP wetlands currently are making to wildlife conservation. However, the wetland restoration literature strongly suggests that wildlife benefits are realized quickly when formerly drained or degraded wetlands are restored. Additional monitoring is needed to gain a better understanding of wildlife responses to management and program benefits for wildlife.

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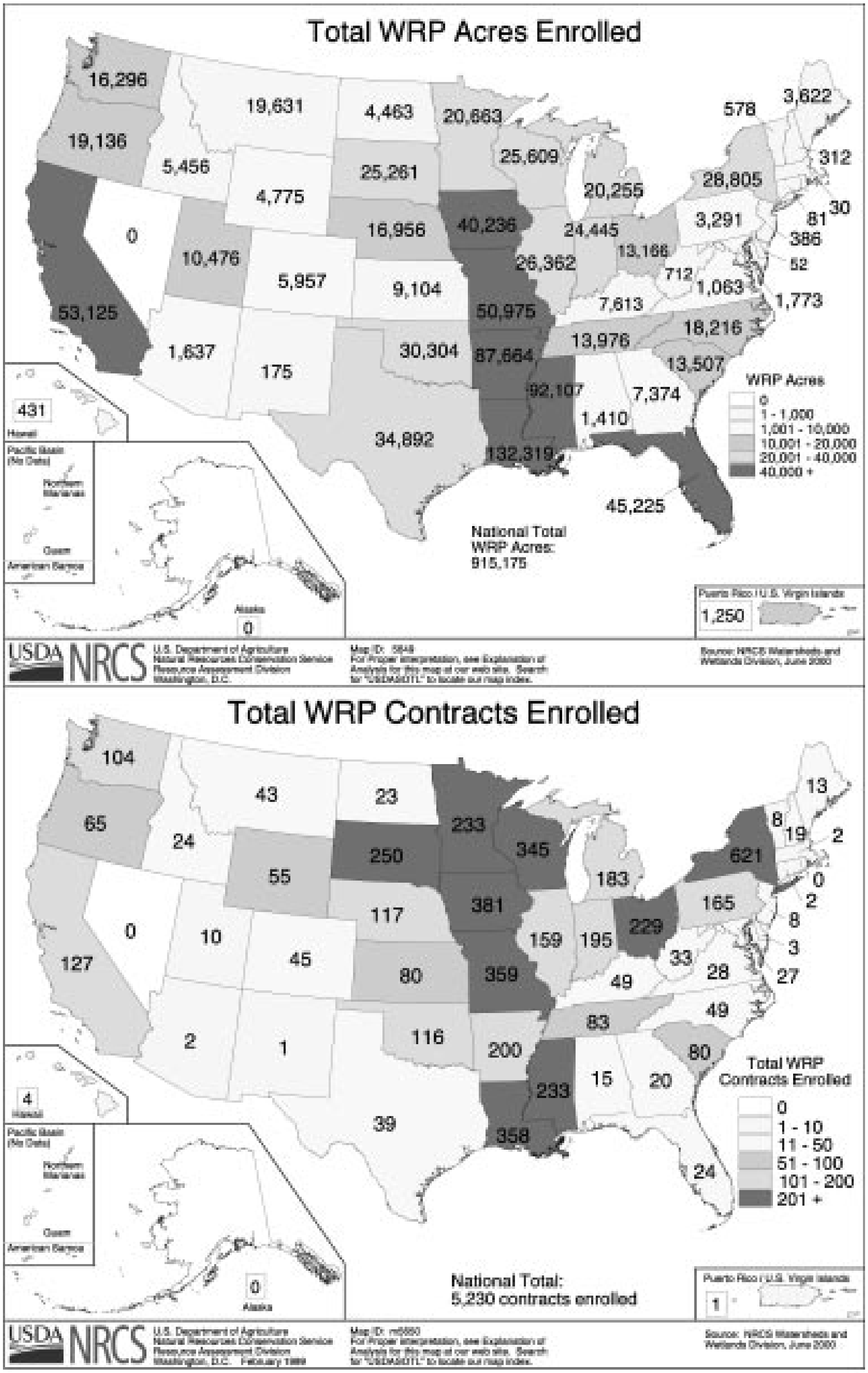


**Figure 1. Wetlands Reserve Program (WRP) enrollment through June 2000 (http://www. wl.fb-net.org/temp.htm).**

**Table 1. Approved bottomland hardwood tree species for WRP in Mississippi.**

| | |
|---|---|
| Bald cypress | Swamp chestnut oak |
| Bitter pecan | Cottonwood |
| Green ash | Sweetgum |
| Overcup oak | Sycamore |
| Nuttal oak | Hackberry |
| Cherrybark oak | Persimmon |
| Swamp white oak | Red maple |
| Southern red oak | Pecan |
| Water oak | American elm |
| Willow oak | Cedar elm |
| Shumard oak | Water tupelo |

Tree species planted is a function of site condition (hydrology and availability of adjacent seed source) and seedling availability.